



Citation for published version:

Kelly, B, Russell, R, Johnston, P, Dunning, A, Hollins, P & Phipps, L 2005, A Standards Framework For Digital Library Programmes. in *ICHIM05 - International Cultural Heritage Informatics Meeting, Proceedings*. ICHIM 2005, Paris, 1/01/05.

Publication date:
2005

Document Version
Peer reviewed version

[Link to publication](#)

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A Standards Framework For Digital Library Programmes

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Abstract

This paper describes a layered approach to selection and use of open standards which is being developed for digital library development work within the UK. This approach reflects the diversity of the technical environment, the service provider's environment, the user requirements and maturity of standards by separating contextual aspects; technical and non-technical policies; the selection of appropriate solutions and the compliance layer.

To place the layered approach in a working context, case studies are provided of the types of environments in which the standards framework could be implemented, from an established standards-based service, to a new service in the process of selecting and implementing metadata standards. These examples serve to illustrate the need for such frameworks.

Keywords: open standards; digital libraries; policies; frameworks; guidelines

1 Earlier Approaches To Use Of Open Standards In The UK

The higher and further education communities in the UK have a culture which is supportive of open standards in its digital library programmes in order to ensure project deliverables are widely accessible and interoperable. These principles underpin the development activities funded by the Joint Information Systems Committee (JISC), a national body which funds national IT services and development programmes for the UK's higher and further education communities. In 1999 the JISC established the Learning and Teaching Programme with the aim of increasing use of online electronic resources by integrating them into the JISC's Information Environment. To ensure that the project deliverables could be easily deployed into a service environment the JISC expected projects to make use of standards documented in the *Standards and Guidelines To Build A National Resource* document (JISC, 2001), which was based on an update of the *eLib Standard Guidelines* document JISC (1998) which supported an early digital library programme, known as eLib, which ran from 1995 until 2001.

However, although projects funded by the eLib programme were expected to comply with the eLib standards document, in practice compliance was never formally checked. This may have been appropriate at that time, before the Web was acknowledged as the prime delivery platform. Now. However, there is now a realisation that compliance with open standards such as XML is necessary in order for digital resources to be widely interoperable. JISC funded the QA Focus project, which was provided by UKOLN and AHDS, to develop a quality assurance framework which would help ensure that future projects would comply with standards and recommendations and make use of appropriate best practices.

Focus group meetings provided feedback on the standards framework. The feedback indicated: (a) a lack of awareness of the standards document; (b) difficulties in seeing how the standards could be applied to projects' particular needs; (c) concerns that the standards would change during the project lifetime; (e) lack of technical expertise and time to implement appropriate standards; (f) concerns that standards may

not be sufficiently mature to be used; (g) concerns that the mainstream browsers may not support appropriate standards and (h) concerns that projects were not always starting from scratch but may be building on existing work and in such cases it would be difficult to deploy appropriate standards. Many of these were legitimate concerns which needed to be addressed in future programmes.

2 Case studies: Open Standards In Practice

2.1 The Arts and Humanities Data Service And Standards For Audio

As a fully functioning digital archive, the Arts and Humanities Data Service (AHDS) serves as a useful case study of how the digital library community can implement a standards framework, both contributing to and gaining from the evolving concepts discussed in this paper.

The task of the AHDS is to collect, disseminate and, most importantly in this context, preserve digital resources in the arts and humanities. Typically, these resources consist of databases, digitised images, audio or video files, virtual reality etc, and are created by academics working at UK universities.

When the AHDS was established in 1996, it set about defining suitable formats for the creation and preservation of digital data. This now manifests itself in an *AHDS Deposit Format* list (AHDS, 2003). This list and related resource – notably *Guides to Good Practice* (AHDS, 2004) and *Information Papers* (AHDS, 2005) – stipulate the formats which should be utilised by resource creators during their digitisation projects.

To facilitate preservation, there is an obvious benefit for the AHDS to mandate open standards – non-proprietary formats that will help maintain free and reasonably straightforward access to the data, hopefully unaffected by changes in the computing environment. For basic data types, such as text and still images, this is a reasonably easy task to accomplish. For text, the AHDS recommends the use of XML; for still images, uncompressed TIFFs. Yet there is a realisation that not all resource creators work according to pre-set standards. Often, this is due to a lack of understanding about their importance, meaning that resource creation projects begin working immediately in the format that is most convenient in the short term, unaware of the long-term issues. In other cases, resource creators will be familiar with particular software and will want to continue to work with it, even if it does not cope well with open formats.

Thus the AHDS Deposit Format list, besides containing a set of Preferable Formats for depositing resources, comprises a list of Acceptable Formats as well. One example where this is particularly relevant is databases. The AHDS preferred format is for databases to be delimited text within an SQL format. This has long-term preservation value whereas a database that has been exported from a proprietary piece of software, such as MS Access or FileMaker Pro, does not. However, the AHDS realises that many people in the community use these applications and that it is easy to export data from MS Access into SQL-compliant delimited text. The AHDS therefore accepts MS Access databases from resource creators and then migrates them into delimited text on arrival.

This need for such flexibility is particularly true when it comes to certain data types where there are no established open standards. Virtual Reality, GIS, Audio and Video are four data types where a slightly different approach is required. For most of these data types open standards do exist. However, for a variety of reasons, it is not possible for the AHDS to stipulate only these as the preferred deposit format – indeed in some cases the open standard is not even considered the preferred standard within the communities who deal with the data type.

Audio is a good example of this. At the date of writing, two of the AHDS's preferred standards for audio digital data are the Microsoft / IBM creation Waveform (commonly known as WAV) and the Apple Macintosh Audio Interchange File Format (AIFF). While both of these are lossless audio formats, ensuring that on creation there is no loss of audio data through compression, they are both proprietary

formats; patents to the codes underlying the formats are owned by their creators and they require plug-in players, licensed by the patent-holders, in order to exploit them.

With such proprietary formats, there is an obvious preservation risk. The patent-holders' business plans may change, affecting how such sound files can be played. It may be that users would have to pay in order to access files in that format, or, should some kind of corporate disaster strike, it could gradually become impossible to access audio files in that format at all.

There are however advantages to these formats. They are well-documented and have good acceptance in various computing communities around the world. And there is a need to balance this against other factors, not least the fact that other existing audio formats tend to be lossy formats and therefore are implicitly not suitable for long-term preservation. The Ogg format has been touted as a possible open standard for audio. But to date Ogg is not widely used - finding tools to record and playback in this format is difficult. It is easier for resource creators to develop, edit, test and analyse files that are created in WAV or AIFF formats. The MP3 format is another popular format, despite being a compression format which discards information on creation. Yet because of its popularity and its current ease of handling, MP3 joins the open standard Ogg as an AHDS Acceptable Format for audio.

Because such formats are continually in flux, the situation requires proactive preservation management from the AHDS. The AHDS needs to ensure it keeps up-to-date with wider shifts in format technology and their uptake. Should a new version of the WAV format be released by Microsoft, the AHDS has to ensure that it obtains the appropriate software to play the files and also migrate the files from the older version of the format to the newer. Developments in other formats, such as Advanced Audio Coding (AAC) and the Apple Lossless format, also need to be tracked. The process of setting standards for digitisation is one that always needs to be reassessed and updated.

2.2 Metadata For The People's Network Discovery Service

The People's Network Service (PNS) is a suite of 'public-facing digital services that is being developed to deliver public library services and resources online'. The PNS initiative is co-ordinated by the Museums, Libraries and Archives Council (MLA). The People's Network Discovery Service (PNDS), one of the initial PNS services, will facilitate access to a range of resources of diverse types and from diverse sources, including cultural sector resources, with an emphasis on those resources designed to foster a 'sense of place'; community information, to highlight local activities; learning resources, for both formal and informal learning; government resources and reference resources.

For the PNDS to offer a new user-facing service that operates across this superset of resources, the PNDS application must be able to (i) obtain access to the metadata databases maintained by resource providers (and/or the resources themselves) and (ii) interpret/process the metadata records to which it obtains access.

The first consideration requires that the provider of a set of resources offers some form of machine-oriented interface to their metadata database and that the developers of the PNDS understand how to interact with that interface; the second requires that there is agreement between the resource provider and the developers of the PNDS on the syntax and semantics of the metadata records which are made available.

2.2.1 Transport Protocols And The PNDS: Prescription And Pragmatism

Prior to the start of the PNDS development work, providers of some of the resources already offered some form of machine-oriented access to their metadata databases e.g. making metadata available for searching (via a Z39.50 target, SRW or SRU server, or some proprietary search API), or harvesting (via an OAI-PMH repository or by extraction from resource content). Within the context of the PNDS, the intention is that the PNDS makes use of these existing mechanisms and additional development effort by the data providers is minimised. For this first subset of PNDS data providers, then, given the range of mechanisms

currently in deployment, access to this metadata is necessarily based on a pragmatic combination of interfaces based on standard protocols on the one hand, and interfaces based on application-specific APIs on the other. In other cases, machine-oriented interfaces were not previously available and the PNDS initiative has provided funding to develop interfaces to provide access to the metadata databases. It should be noted that both the PNDS and the data provider services are located within a broader information landscape, in which, increasingly, independently created components are used in combination to provide functions of interest to users. MLA is committed to long-term strategies to achieve this sort of integration of services. For this second subset of data providers, then, the PNDS initiative presented an opportunity to ensure that metadata was exposed through mechanisms which not only facilitated the development of the PNDS, but also met broader requirements for the development of other metadata-based services by other parties. Although there is no formal standards framework specifically for the PNDS - and given the diversity referred to in the previous paragraph, it would be difficult to apply such a framework to all the PNDS data providers - MLA draw attention to the technical guidance produced through the Minerva project (Minerva, 2003), which builds on the guidelines used within the NOF-Digitise programme (NOF-Digitise, 2003). The recommendation for the cultural sector data providers within the PNDS is that they should provide access to their metadata databases via the Open Archives Initiative Protocol for Metadata Harvesting (OAI-PMH, n.d.) - unless either a search interface is already available or the rate of change to the metadata is such that 'real time' access to the source database (rather than the periodic harvesting of its content) is necessary to provide an effective disclosure/discovery function.

One consequence of the 'pragmatic' approach to the diversity of the PNDS data provider landscape is that the architecture of the PNDS application itself is relatively complex: it must interact with a range of data providers using several different protocols and APIs, supporting the cross-searching of remote targets and of the "local" aggregated metadata database built by the (managed) periodic harvesting of the OAI-PMH repositories.

2.2.2 Metadata Standards, Metadata Application Profiles And The PNDS: Generality And Contextualisation

The selection of a protocol by which metadata records can be exposed meets only part of the requirement for the effective exchange of metadata between data providers and the PNDS: the data providers and the developers of the PNDS must also have a shared understanding of the conventions used to represent information in those metadata records - typically achieved by the adoption of metadata standards.

It is a requirement of the OAI-PMH specification that all data providers must support the 'oai_dc' 'metadata format', an XML format for the serialisation of 'simple Dublin Core' metadata descriptions. Although the oai_dc format is quite limited in terms of its expressivity - it supports metadata descriptions containing statements made using only the 15 properties of the Dublin Core Metadata Element Set (Dublin Core) - many services have been built using that format, and it has served as a 'baseline' for semantic interoperability between services. For the PNDS, however, the goal was to offer a richer range of user functions than the oai_dc format could support (e.g. to be able to search for items associated with a specified location).

Two points should be emphasised here. Firstly, the OAI-PMH is not limited to the harvesting of metadata records in the oai_dc format; the protocol supports the exposure of metadata serialised in any XML format (provided that the format is described using W3C XML Schema). Secondly, Dublin Core is not a single fixed metadata format, but rather a framework for the construction of metadata descriptions and a small vocabulary of metadata terms that can be referenced in combination with terms provided by other agencies in those metadata descriptions. The Dublin Core Metadata Initiative recognises that the deployment of Dublin Core metadata takes place within the context of a domain or community with specific requirements and that the implementation of the standard is tailored to meet those requirements. The notion of the Dublin Core 'application profile' (DCAP) has been developed to reflect this reality: a

DCAP specifies the set of metadata terms that are used within some particular class of DC metadata descriptions, and how those terms are used (Heery and Patel, 2000).

For the PNDS, firstly, a DCAP was developed to reflect the functional requirements outlined for the PNDS (PNDS DCAP). The use of that DCAP enables data providers to provide information such as the ‘spatial coverage’ of a resource or the license under which a resource is made available, neither of which it is possible to disclose using the oai_dc metadata format. Secondly, an XML binding was provided so that metadata descriptions conforming to that DCAP can be serialised as XML documents and made available as OAI-PMH metadata records. The cultural sector data providers to the PNDS are required to support the provision of metadata records in this format.

The PNDS DCAP is itself relatively permissive: the set of data which is required within a PNDS DCAP metadata description is relatively small. Again this reflects the diversity amongst data providers: while some hold (or can generate) relatively rich descriptions of their resources, others hold only minimal descriptive metadata. At the time of writing, it remains to be seen whether the metadata records aggregated by the PNDS are sufficiently rich to support all the functional requirements expected for the service.

Although the PNDS DCAP was designed primarily to support the requirements of the PNDS, its design takes into account standards and good practices within the broader UK context, e.g., in the choice of controlled vocabularies used for some of the properties. The records using that metadata format are also available for harvesting by other service providers who wish to make use of the information that they contain in their own services. Also any data provider can choose to make metadata available via OAI-PMH in additional metadata formats to support the requirements of other services or other communities.

2.2.3 The PNDS And Standards

The approach taken to standards within the PNDS, then, reflects some frequently encountered tensions: (a) between the drive to enhance interoperability between services by adopting common, standards-based interfaces and the recognition that the development effort available to data providers may be limited and a business case must be made for such provision; (b) between the concern for generality and commonality on the part of standards bodies and for localisation, specificity and efficiency on the part of service providers and (c) between the desire to develop services that operate across a broad range of resources and the difficulty of obtaining a set of metadata records sufficiently rich to support the same functions across all the resources concerned.

2.3 RSS Or RSS?

Another example of the difficulties in the selection of open standards can be seen by examining a popular standard for news feeds and content syndication. The RSS format provides a lightweight but powerful mechanism which can be used for syndication of news items. RSS can also be used for providing dynamic updates, such as alerts of the availability of new resources on Web sites, new search results, etc. The popularity of RSS has been helped by its use within Blogs for the syndication of Blog articles and use by popular Web-based services such as del.icio.us, Flickr, etc.

It might be expected that such a widely-deployed format would have a clearly-defined specification and standards body responsible for its ownership and maintenance. In fact the governance of RSS is very confused, not least because there are two standards and RSS has three different meanings! RSS was originally developed by Netscape for use with the My.Netscape portal and then stood for *Rich Site Summary*. The potential for RSS was quickly acknowledged, and, as Netscape suffered organisational difficulties, RSS was transformed into a RDF application and RSS 1.0 became known as *RDF Site Summary*. However other developers felt that RDF was too complex and that RSS should remain a simple, lightweight format. RSS 2.0 was released, with the abbreviation standing for *Really Simple Syndication*.

The RSS 1.0 specification (RSS, 2005a) is maintained by Aaron Swartz on behalf of the RSS-DEV Working Group. On his Web site Aaron describes himself as “a teenage writer, hacker, and activist” (RSS, 2005b). The author of the RSS 2.0 specification (RSS, n.d.) is Dave Winer, who subsequently made the document available to the Berkman Center for Internet & Society at Harvard Law School under a Creative Commons licence. The Wikipedia entry for Dave Winer states that “Winer's detractors allege that he is overly blunt and thin-skinned.” (Wikipedia, 2005).

We can see that although RSS is widely used within digital library applications, there are confusions over the competing versions and there is no authoritative body which is responsible for the governance of one of the standards.

2.4 Limitations Of Web Accessibility Guidelines

The importance of broad accessibility to digital resources is widely acknowledged. Within the World Wide Web Consortium (W3C) the Web Accessibility Initiative (WAI) has taken the lead in promoting the importance of accessibility and has developed a set of guidelines (the Web Content Accessibility Guidelines or WCAG (WCAG) which, along with the guidelines for authoring tools and user agents, aim to provide guidance on best practices for ensuring that Web resources are widely accessible.

It would appear that a globally acknowledged standard for accessibility has been developed and that the WAI guidelines should be adopted by all. In reality, however, the approach developed by WAI has flaws. As described by Kelly *et al* (2005) the WAI model, which is based on three components (guidelines for authoring tools and user agents, in addition to guidelines for Web content), is a theoretical model for Web authors, as they have no control over the provision of browsers or authoring tools.

As well as the flaws in the WAI model, the WCAG guidelines themselves are flawed. Kelly *et al* (Kelly, 2004) have argued that the poor level of compliance with WCAG guidelines which has been observed in many sectors (including higher education, museums and even disability organisations themselves) reflects, not necessarily a lack of motivation to support users with disabilities but rather a failing in the guidelines themselves. In the light of these issues the authors feel that a slavish commitment to WAI guidelines is inappropriate and that an alternative approach is needed. A holistic framework for e-learning accessibility has been developed by Kelly *et al* (2004) which takes a user-focused approach to Web accessibility, rather than the conventional checklist approach. This framework is illustrated in Figure 1.

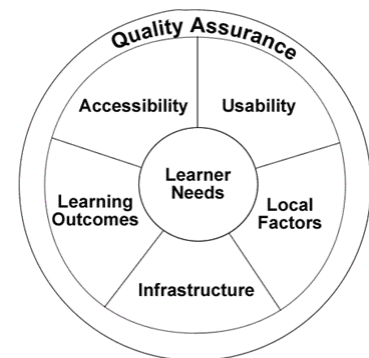


Figure 1: Holistic Framework For E-Learning Accessibility

3 A Layered Approach To Use Of Standards

3.1 Background

We have seen several examples in which, although open standards are available, their selection and use is not necessarily clearly defined, cases in which the openness of a standard is questionable and other cases in which the merit of open standards is open to debate.

Developers of digital library services which seek to make use of open standards will be left in an uncertain position as to how best to proceed. Should the commitment to open standards be abandoned due to the inherent difficulties? Should such difficulties be ignored and use of open standards be formally required? Kelly *et al* (2003) argue for an open standards culture, which is supportive of the use of open standards, but acknowledges the difficulties this can entail. In this paper the authors describe an approach which builds on this.

We argue that there is a need to recognise the contextual nature to this problem; i.e. there is not a universal solution, but rather the need to recognise local, regional and cultural factors which will inform the selection process. We have developed a layered approach. This can be used in developing the environment in which standards can be selected within digital library development work, relevant standards selected for use and usage monitored. This approach is illustrated in Figure 2.

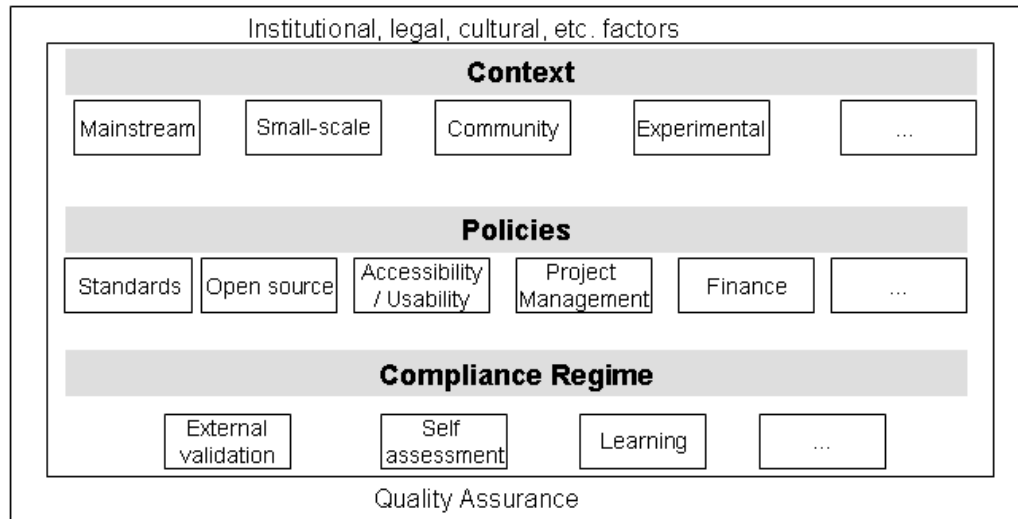


Figure 2: A layered approach to use of standards

This approach uses the following layers:

Contextual layer: This reflects the context in which the standards are being used. Large, well-funded organisations may choose to mandate strict use of open standards in order to build large, well-integrated systems which are intended for long term use. For a smaller organisation, perhaps reliant on volunteer effort with uncertain long-term viability, a simpler approach may be more appropriate, perhaps making use of proprietary solutions.

Policy layer: This provides a description (or catalogue) of relevant policies in a range of areas. The areas will include descriptions of standards, the topic of this paper.

Compliance layer: This describes the mechanisms which will be used in order to ensure that development work complies with the requirements defined within the particular context. For large, public funded programmes there could be a formal monitoring process carried out by external auditors. In other contexts, projects may be expected to carry out their own self-assessment. In such cases, the findings could be simply used internally within the project, or, alternatively, significant deviations from best practices could be required to be reported to the funding body.

It should be noted that, although it will be possible to deploy this three-layered approach within a funding programme or community, there will be a need to recognise external factors, over which there may be no control. This may include legal factors, wider organisations factors, cultural factors, etc.

It should also be noted that, in addition to the technical policies, there will be related policy areas. This may include policies on open source software, policies on usability and accessibility, as well as policies in non-technical areas, such as project management, finances, etc. The important point to note is that these policies need to be developed in the knowledge that related policies are being developed, in order to ensure no duplication or confusions. For example, it would be inappropriate for the policy on standards to describe use of WCAG AA guideline if the accessibility standard describes an alternative approach.

3.2 Using This Approach

The approach outlined above has been developed for the JISC to support its development programmes. The layered approach is being used to allow the technical standards catalogue to be developed without the authors needing to concern themselves with the particular context in which the standards may be used, or any possible penalty clauses which could be applied if the standards were not used correctly.

JISC programme managers are then able to mandate areas in which strict compliance is a contractual requirement, areas in which compliance would be desirable and areas in which projects are left to select the most appropriate solution for their area of work and organisational context. So, for example, a programme which is seeking to explore the potential for e-prints repositories could mandate use of the OAI-PMH standard, but simply request that projects seek to ensure that Web sites comply with best practices in use of HTML and leave projects free for themselves to choose the most appropriate scripting languages or content management system to manage their resources. Similarly the programme managers can define the compliance regime – for example there may be a contractual requirement that project deliverable will pass a OAI-PMH interoperability test suite and an expectation that the projects will report on any significant deviances from best practices for the Web site, whilst leaving the projects to define for themselves processes for ensuring that the Web site is usable.

3.3 Application To E-Learning

The Centre for Technological Interoperability Standards (CETIS) represents the UK Higher and Further-education institutions on international learning technology standards initiatives. CETIS has been instrumental in the development of the JISC e-framework which is being deployed across JISC activities. The e-framework makes use of Web Services and a Service Oriented Architecture (SOA), together with the application of open learning technology specifications and standards such as those developed by the specification bodies such as the IMS Global Learning consortium and ADL and formal standards bodies including The British Standards Institute (BSI) and the International Standards Organisation (ISO) the Institute of Electrical Engineers (IEEE).

As we will see, the three layered contextual approach described above could equally be applied to the use of open learning technology standards. Historically, the lack of recognition of these factors have in some cases resulted in the mandation of specifications; prematurely, where the specification is an early iteration, inappropriately, where the specification is applied out of context and without due consideration of institutional, legal (particularly Intellectual Property Rights Issues) and cultural considerations.

The adoption of a specification, either formal or *de facto*, is subject to an often lengthy life cycle which involves a lengthy iteration process before they are of “useable” value. To mandate an immature specification (one that is in the early stages of its adoption life cycle) in this process can result in the specification not accommodating community or project requirements for use.

A good example of inappropriate mandating has been the widespread application of the ADL Shareable Content Object Reference Model (SCORM) to content development. SCORM was designed contextually as a specification where detailed complex “tracking” of learner activities, responses and assessment are required, as required when training aircraft engineers et al where compliance is a key driver. It would be clearly inappropriate to apply SCORM in a Higher Education setting with an emphasis on a constructivist or collaborative approach to learning, where in context “compliance” assumes little or no importance.

Cultural barriers to the use of standards exist as is the case with the current drive at a policy level towards e-Portfolio or the European Diploma supplement (EDS) supported by open specifications such as IMS Learner Information Profile, UK LEAP, etc. Cultural concerns surround issues such as ownership of and access to the data contained in the portfolio, the validation and security of data which in turn impact on both institutional, student records and admissions, and legal, data protection and freedom of information factors.

4 The Project's Perspective

The layered approach described above has been designed to provide a framework for the use of standards with digital library programmes which, whilst supportive of use of open standards, acknowledges that this may not always be possible. How, though, is this approach to be used by projects?

We have developed another layered approach for use by projects which is illustrated in Figure 3.

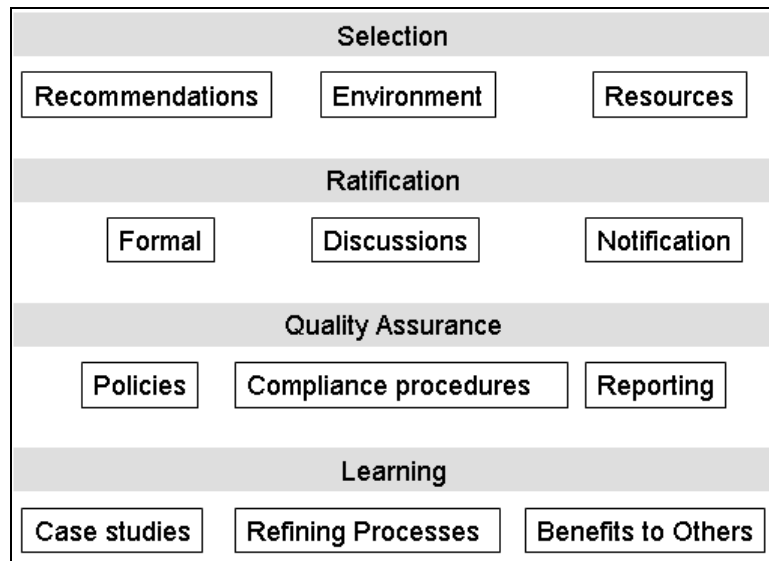


Figure 3: Layered approach from a project's perspective

Projects will be aware of four distinct phases, two which take place during the initial project development period, one during development work and one which takes place towards the end of the project's life:

Selection: In many cases projects will have some flexibility in choosing standards. The selection process should reflect the open standards culture inherent in the programme, whilst allowing some flexibility which reflects the content of the development environment. A matrix for the selection of standards has been developed to support this decision-making process (QA Focus, 2004).

Ratification: A potential danger could be that projects seek to use the methodology as an excuse to continue to use existing formats, tools and working practices. In order to avoid such inertia there should be a ratification stage, in which the decisions made by the projects can be agreed or rejected by the programme funders.

Quality Assurance: Projects will need to implement quality assurance procedures to ensure that the policies which have been made are being implemented correctly.

Review/Learning: The final stage is for a review of the process which can provide an opportunity for learning. Projects should provide feedback on both the approach used across the digital library programme and on specific aspects, such as comments on particular technologies and standards.

5 Conclusions

This paper has considered some of the difficulties associated with the use of open standards. We have provided several case studies which illustrate several of the challenges which can be faced when seeking to make use of open standards. The paper describes a model which provides a contextual approach to selection and use of open standards within digital library development programmes. This model aims to provide a pragmatic solution and is designed to provide guidance and support for projects and services in implementing standards-based solutions, without being overly prescriptive.

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About The Authors

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Rosemary Russell has worked for UKOLN at the University of Bath since 1995, where she is currently Interoperability Focus Officer. She has both managed and participated in a number of projects and initiatives to progress interoperability (semantic, technical and organisational) across information services, and across sectors.

Pete Johnston is a Research Officer at UKOLN at the University of Bath. Pete's effort is divided between the work of the Interoperability Focus on promoting strategies for the effective exchange and reuse of information and a research project on metadata registries. Pete is an active contributor to the work of the Dublin Core Metadata Initiative: he is currently a member of the Dublin Core Metadata Initiative Advisory Board and chair of the Dublin Core Collection Description Working Group.

Alastair Dunning works at King's College London for the UK Arts and Humanities Data Service, a digital archive for research resources in the arts and humanities. He has had much experience in the application of standards, particularly in advising museums, universities and individual scholars in building digital resources funded by the New Opportunities Fund and the Arts and Humanities Research Council.

Lawrie Phipps is the TechDis Senior Advisor for Higher Education in the UK. His background is in staff development and e-learning, designing and developing virtual field trips and courses and supporting science lecturers in learning and teaching. Within TechDis Lawrie is currently working on issues of accessibility and pedagogy, e-learning as a tool for empowerment of disabled students and e-learning policy and strategy.

Paul Hollins is Manager of the Centre for Educational Technological Interoperability Standards (CETIS) hosted by the University of Bolton. CETIS represents the UK HE and FE communities on international learning technology standards initiatives.